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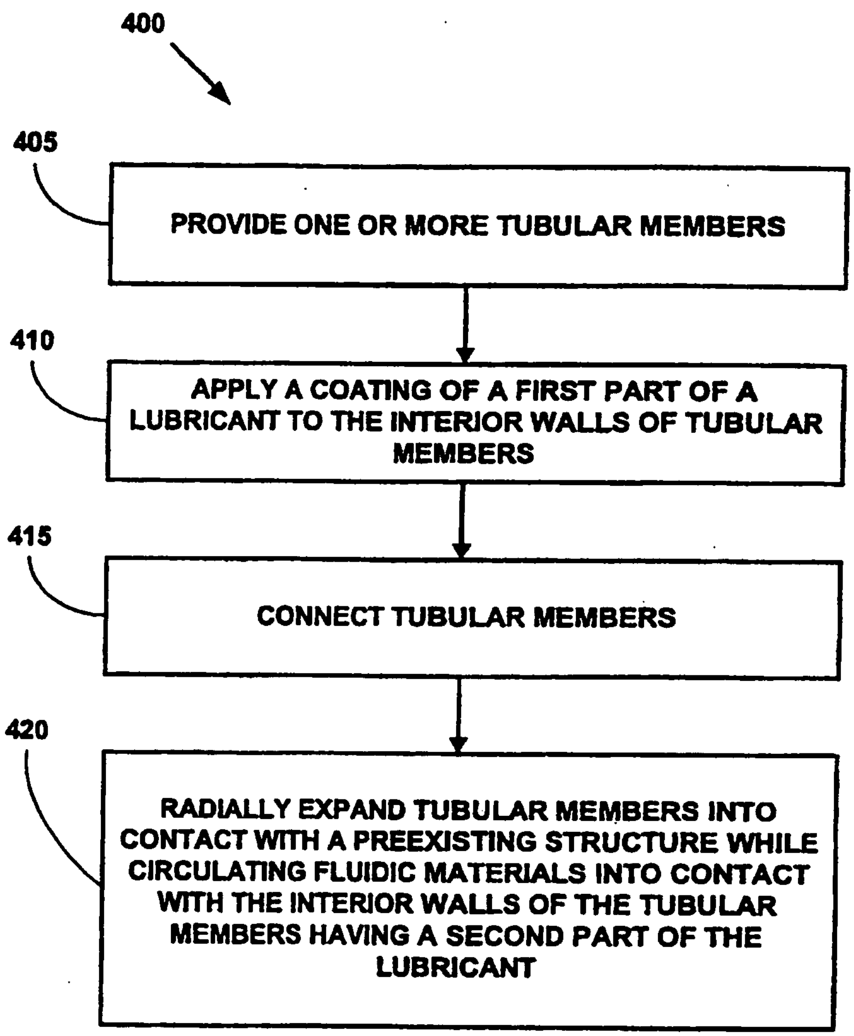

FIGURE 1

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LUBRICANT COATING FOR EXPANDABLE TUBULAR MEMBERS

Background of the Invention

This invention relates generally to tubular members, and in particular to lubricant coatings for tubular members that are formed using expandable tubing.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming wellbores.

Summary of the Invention

According to a first aspect of the present invention there is provided a method of coupling an expandable tubular assembly including one or more tubular members to a preexisting structure, comprising:

coating the interior surfaces of the tubular members with a first part of a lubricant;

positioning the tubular members within a preexisting structure;

circulating a fluidic material including a second part of the lubricant into contact with the coating of the first part of the lubricant; and

radially expanding the tubular members into contact with the preexisting structure.

According to a further aspect of the present invention there is provided an apparatus, comprising:

a preexisting structure; and

one or more tubular members coupled to the preexisting structure by the process of:

coating the interior surfaces of the tubular members with a first part of a lubricant;

positioning the tubular members within a preexisting structure;

circulating a fluidic materials having a second part of the lubricant into contact with the coating of the first part of the lubricant; and

radially expanding the tubular members into contact with the preexisting structure.

Preferably, the tubular members comprise wellbore casings.

Preferably, the tubular members comprise underground pipes.

Preferably, the tubular members comprise structural supports.

Preferably, the lubricant comprises a metallic soap.

Preferably, the lubricant comprises zinc phosphate.

Preferably, the lubricant provides a coefficient of friction of between 0.02 to 0.08.

Preferably, the second part of the lubricant is selected from the group consisting of:

sodium stearates, calcium stearates, zinc stearates, zinc phosphate, manganese phosphate, polytetrafluoroethylene, molybdenum disulfide, and metallic soaps.

Preferably, the lubricant provides a sliding coefficient of friction less than 0.20.

Preferably, the second part of the lubricant is selected from the group consisting of:

polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol/vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes, styrene butadiene latex, urethane latexes, styrene-maleic annhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including

styrene, block copolymers including isoprene butadiene, block copolymers including ethylene, and ethylene acrylic acid copolymers.

Preferably, the second part of the lubricant is selected from the group consisting of:

graphite, molybdenum disulfide, lead powder, antimony oxide, poly tetrafluoroethylene, and silicone polymers.

Preferably, the lubricant comprises a suspension of particles in a carrier solvent.

Preferably, the first part of the lubricant is selected from the group consisting of:

manganese phosphate, zinc phosphate, and iron phosphate.

Preferably, the first part of the lubricant comprises 1 to 90 percent solids by volume.

Preferably the first part of the lubricant comprises 5 to 70 percent solids by volume.

Preferably, the first part of the lubricant comprises 15 to 50 percent solids by volume.

Preferably, the first part of the lubricant comprises:

5 to 80 percent graphite;

5 to 80 percent molybdenum disulfide;

1 to 40 percent PTFE; and

1 to 40 percent silicone polymers.

Preferably, the lubricant comprises one or more of the following: ester; sulfurized oil; alkanolamides; amine; amine salt; olefin; polyolefins; C-8 to C-18 linear alcohol; derivative of C-8 to C-18 linear alcohol including ester; derivative of C-8 to C-18 linear alcohol including amine; derivative of C-8 to C-18 linear alcohol including carboxylate; sulfonate; polyethylene glycol; silicone; siloxane; dinonyl phenol; and ethylene oxide/propylene oxide block copoloymers.

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sodium stearates, calcium stearates, zinc stearates, zinc phosphate, manganese phosphate, polytetrafluoroethylene, molybdenum disulfide, and metallic soaps.

Preferably, the lubricant provides a sliding coefficient of friction less than 0.20.

Preferably, the second part of the lubricant is selected from the group consisting of:

polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol/vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes, styrene butadiene latex, urethane latexes, styrene-maleic annhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, block copolymers including isoprene butadiene, block copolymers including ethylene, and ethylene acrylic acid copolymers.

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Preferably, the lubricant comprises a suspension of particles in a carrier solvent.

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Preferably, the first part of the lubricant comprises 5 to 70 percent solids by volume.

Preferably, the first part of the lubricant comprises 15 to 50 percent solids by volume.

Preferably, the first part of the lubricant comprises:

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5 to 80 percent molybdenum disulfide;

1 to 40 percent PTFE; and

1 to 40 percent silicone polymers.

Preferably, the lubricant comprises one or more of the following: ester; sulfurized oil; alkanolamides; amine; amine salt; olefin; polyolefins; C-8 to C-18 linear alcohol; derivative of C-8 to C-18 linear alcohol including ester; derivative of C-8 to C-18 linear alcohol including amine; derivative of C-8 to C-18 linear alcohol including carboxylate; sulfonate; polyethylene glycol; silicone; siloxane; dinonyl phenol; and ethylene oxide/propylene oxide block copolymers.

Brief Description of the Drawings

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawing, in which:-

Fig. 1 is a flow chart illustrating a method for coupling a plurality of tubular members to a preexisting structure.

Detailed Description

As illustrated in Fig. 1, a method 400 for forming and/or repairing a wellbore casing, pipeline, or structural support includes the steps of: (1) providing one or more tubular members in step 405; (2) applying a coating including a first part of a lubricant to the interior walls of the tubular members in step 410; (3) coupling the first and second tubular members in step 415; and (4) radially expanding the tubular members into contact with the preexisting structure while also circulating fluidic materials into contact with the interior walls of the tubular members having a second part of the lubricant in step 420.

In step 410, a coating including a first part of a lubricant is applied to the interior walls of the tubular members. The first part of the lubricant forms a first part of a metallic soap. The first part of the lubricant coating includes zinc phosphate.

In step 420, a second part of the lubricant is circulated within a fluidic carrier into contact with the coating of the first part of the lubricant applied to the interior walls of the tubular members. The first and second parts react to form a lubricating layer between the interior walls of the tubular members, and the exterior surface of the expansion cone. In this manner, a lubricating layer is provided in exact concentration, exactly when and where it is needed. Furthermore, because the second part of the lubricant is circulated in a carrier fluid, the dynamic interface between the interior surfaces of the tubular members, 205 and 215, and the exterior surface of the expansion cone is also preferably provided with hydrodynamic lubrication. The first

and second parts of the lubricant react to form a metallic soap. The second part of the lubricant is sodium, calcium and/or zinc stearate.

In several experimental operations of the method 400, the following observations were made regarding lubricant coatings for expandable tubular members:

(1) boundary lubrication with a lubricant coating having high adhesion (high film/shear strength) to the expandable tubular is the single-most important lubricant/lubrication process in the radial expansion process;

(2) hydrodynamic lubrication plays a secondary role in the lubrication process;

(3) expandable tubular lubricant coating offers the more reliable and more effective form of boundary lubrication;

(4) a liquid lubricant viscosity and/or film strength that provides effective, consistent boundary lubrication typically limits the effectiveness of additives for the mud alone to provide the necessary lubrication while maintaining drilling fluid properties (rheology, toxicity);

(5) consistent reductions of 20 to 25 percent in propagation force during the radial expansion process (compared to uncoated expandable tubular control results) were obtained with the following dry film coatings: (1) polytetrafluoroethylene (PTFE), (2) molybdenum disulfide, and (3) metallic soap (stearates), these results are for laboratory tests on one inch dry pipe, in the absence of any drilling fluid;

(6) a 20 to 25 percent reduction in propagation force during the radial expansion process was observed;

(7) synthetic oil muds do not typically provide sufficient, reliable lubrication for uncoated pipe;

(8) the coefficient of friction for expandable tubular lubricant coatings remains essentially constant across a wide temperature range;

(9) the expected application range for expandable tubular casing expansion is between 40 °F and 400 °F (4°C and 204°C), this range is well within the essentially constant range for coefficient of friction for good coatings; and

(10) good extreme pressure boundary lubricants have a characteristic of performing better (lower coefficients of friction) as the load increases, coefficients of friction between 0.02 and 0.08 are reported for some coatings.